Exploring And Understanding The Benefits Of Tutoring Software On Urban Students' Science Achievement: What Are Baltimore City Practitioners' Perspectives?

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ABSTRACT

Historically, very little research that meets the scientifically based standards as defined by the No Child Left Behind Act has been conducted on the effectiveness of educational technology on student achievement. The purpose of this study was to explore and seek to understand urban city teachers' perspectives on the benefits or effects of computer software tutors on their urban students' science achievement (from interviews with Baltimore City teachers). Three Baltimore City practitioners were interviewed on February 7, 2008 for their perspectives on tutoring software and its benefits to urban students. Results indicated that Baltimore City teachers felt that tutoring software is beneficial to urban students. Qualitative results further revealed: sixty-six percent of those practitioners interviewed indicated that tutoring software was good for reinforcing and supporting lectures, sixty-six percent of practitioners interviewed also indicated that tutoring software can serve as a great motivational tool for science students, and sixty –six percent of those interviewed talked about the effectiveness of tutoring software in possibly helping to improve high stakes science test scores for K – 12 students. Interview data results seemed in line with quantitative data reporting by Kulik (2002) and Willis (2000) who found correlations between tutoring software usage and increase students' attitudes toward science and increase science achievement. In light of a few limitations of this study and taking into account the gaps or limitations existing in the literature, it is recommended that more qualitative studies be conducted that can explore and seek to understand the perspectives of urban teachers with regards to their perceived benefits of technology on students' science achievement.

{Conference Research Paper, 13 references}

CHAPTER 1- INTRODUCTION

The most effective science education gives students the chance to observe, engage, invent, or discover expert strategies in context. In this way, learning experiences move students beyond the mechanistic learning of the processes of science to the development of attitudes and dispositions toward inquiry (Moss, 2001). Additionally, the U.S. Department of Education is investing more than 56 million dollars in order for more studies to be conducted that will examine the impact(s) of technology on k-12 students' performances (Bailey, 2004).

PURPOSE

The purpose of the study was to explore, examine, and seek to understand the possible benefits of computer software tutors on urban students' science achievement (from interviews with BCPSS teachers).

STATEMENT OF THE PROBLEM

Historically, very little, if any, research that meets the scientifically based standards as defined by the No Child Left Behind Act has been conducted on the effectiveness of educational technology (Bailey, 2004). Further, in an effort to address the growing need for more scientifically based studies to be conducted in an attempt to document the benefits of educational technology on k-12 students' academic achievement, the U.S. Department of Education is investing more than 56 million dollars in order for more studies to be conducted that will document the impact of educational technology on k-12 student performance (Bailey, 2004).

In light of the aforementioned needs and demands, this study was designed in order that there may be more documentation on the effects or benefits of tutoring software on urban students' science achievement.

SIGNIFICANCE OF THE PROBLEM AND CONTRIBUTIONS OF THE STUDY

According to Bailey (2004), historically, very little, if any, research that meets the scientifically based standards as defined by the No Child Left Behind Act has been conducted on the effectiveness of educational technology. Clearly, the educational technology community must invest in research and evaluation studies to better guide the effective use of the investment, as well as to demonstrate to policy-makers the impact of educational technology on science and mathematics learning. To this affect, the U.S. Department of Education has invested more than 56 million dollars in order to try to begin crucial studies that may be able to document some of the possible effects of technology on student's performance, particularly in mathematics and science (Bailey, 2004).

Moreover, the significance of this study lies in its:

(a) Addressing the outstanding deficiencies (limitations) in the present literature

(b) Potential contribution to the literature on the topic

(c) Ability to inform all stakeholders (teachers, administrators, parents, students & others)

LIMITATIONS / GAPS IN LITERATURE

Firstly, very little studies have been conducted that explore the effects of tutoring software (specifically) on students' science achievement. Secondly, of the few studies that are available (see Willis, 2000; Johnson & Holder, 2002, 2003; Walsh et al., 2002), they are all of a quantitative nature and have been conducted with non-urban students. However, this study fills in the existing gap / limitation in the education literature by:

(a) Utilizing a qualitative perspective – i.e. a phenomenological inquiry approach – utilized in order to get the clientele – the teachers' perspectives on the issue

(b) Looks at the urban teachers views on the benefits of the learning software for their urban students

RESEARCH OBJECTIVE

(1) To explore and understand urban city teachers' perspectives on the benefits or effects of tutoring software on their (urban) students' science achievement

Types of Tutoring Software

Quantum (artificial) intelligence tutor - is interactive software for chemistry, mathematics, and accounting students and it is software that can create work out solutions with detailed explanations for chemistry, mathematics, and accounting students.

Bio tutors - are interactive software for biology students

CHAPTER 2 – REVIEW OF LITERATURE

According to the National Science Educational Standards, Teaching Standard A (National Research Council's Report), science curriculum and lesson should originate and be designed around the interests, knowledge, understanding, ability, and experiences of the science students (Krantz, 2003). Additionally, some elementary, middle, and high school students have difficulty with understanding the basic elements of the periodic table, balancing chemical equations, and understanding the bonding processes in chemistry, so teachers have to plan alternative activities that may engage students in their own learning process (Wolfinger 1984, pg.62-3). Such a process of engagement can generate a variety of perspectives on a topic, provide depth to content, and lead to a significant understanding of concepts. Further, according to the socio-cultural and social constructivist theories, effective teaching must be improvisational

because if the classroom is scripted and directed by the teacher, the students can not co-construct their own knowledge (Sawyer, 2004).

According to Kozma et. al., (1997), the traditional discourse of students in K-12 classrooms rarely results in extended inquiry or shared meaning. It was discovered that in order for effective science learning to occur, teachers and principals have to restructure science classrooms around the social construction of meaning (Kozma et. al, 1997). So in the end, the intent of this restructuring is to have students actively engaged in a questioning and explanation process. It has been found that technology plays a significant role in the restructuring of traditional classroom lectures and in the involvement process of students in their own learning. More specifically, chemistry software environments have been found to be great tools in providing students with useful inquiry and for providing engaging activities that facilitates and extends classroom learning.

Intelligence tutors and its relations to inquiry base research and effective science learning

Current educational theories emphasize the 'active, reflective and social nature of learning" (Kozma & Jacobson, 2000). Learners have to be active constructors of knowledge; they are no longer to be seen as 'passive receivers' of transmitted information (Freire, 2005; Kozma & Jacobson, 2000). Computer applications associated with constructivist learning are typically designed as 'interactive learning environments' that emphasize student – directed learning activities (Kozma & Jacobson, 2000).

Quantum tutors relate to effective science learning and teaching; in that, it allows for constructivists and conceptual change ideals to be brought into science classrooms.

A statement written in support of this was:

> *"The tutors use further prompts to pull a student's thinking beyond his / her current level of understanding, which helps the student rethink existing understandings, to wonder why, to ask questions, to form hypotheses, and to make explicit connections" (Moss, 2001, pgs. 2-3).*

Also,

> *"By allowing students to move from what they know – even if they know very little- the tutors help students construct knowledge that can be activated in the future" (Moss, 2001, pg.3).*

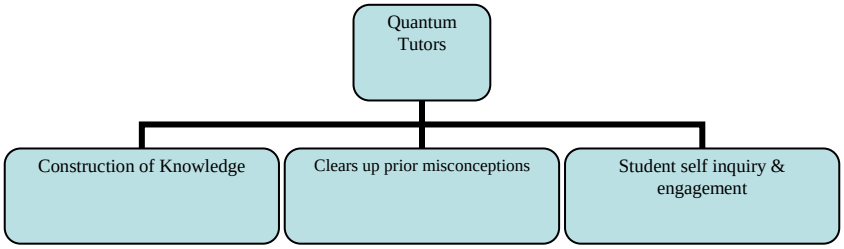
So, inquiry base learning allows the student to control his / her own learning through the guidance of the quantum tutors software (constructivist ideal). Accordingly, through controlling their own learning processes, these students can ask their own questions which allow them to be able to reflect on and to clear up prior misconceptions (conceptual change theory at play).

Benefits of Quantum (artificial) tutors

There are several benefits of quantum (artificial) tutors:

- It engages students in significant learning and inquiry regardless of whether they are proficient or not on science concepts.
- Allows students to direct their own inquiry
- Provides support for students, from an initial 'hand holding' stage to a more advance conceptual understanding stage.
- Engages students in active thinking, problem solving, and scientific inquiry
- Provides questioning, modeling, illustrations and explanations like those of a teacher

Figure 1: Theoretical / Conceptual Model Associated With Interactive Tutors



Quantum (intelligence) tutors and student achievement

Six reports were published since 1990 in the *Effects of Using Technology Journal* which evaluated computer tutorials benefits in science subjects. The studies were carried out in the USA and abroad and in such courses as chemistry, biology, meteorology, and social science. Even though the studies were of short duration and lasted for either ten days (shortest) or three months (longest), they all produced fruitful results (Kulik, 2002). According to Kulik (2002), in all but one of the six cases, the effect of computer tutoring was large enough to be considered both statistically significant and educationally meaningful. Specifically, the effect of computer tutorials was proven to be significant; in that, it raised students' science achievement scores by 0.59 standard deviations, or from the 50^{th} to the 72^{nd} percentile. Also tutorials were found to have a strong and positive effect on student attitudes toward instruction and subject matter. Attitude

scores were raised by 1.10 standard deviations as a result of students utilizing tutorials as a part of their studies (Kulik, 2002).

In another study, Willis (2000) performed an experimental study in which he divided 51 high school students into two unequal groups. Group 1 comprising of 31 students served as the experimental / treatment group and group 2 (20 students) served as the control group. Willis (2000) found as a result of his experimental study that quantum (artificial) tutor was very effective in increasing students' test scores and thus in improving students' chemistry performance. He found that students using the quantum tutors (treatment group) out performed the control group on the post test by an average of 12.8 points or by a full letter grade. Also, among the treatment group, post test scores (post test was administered after treatment) were significantly higher than pre test scores (pre test was administered before treatment).

In another research conducted by Duquesne University in Pennsylvania, they evaluated the effectiveness of quantum tutors (for oxidation numbers) on the performance of university science majors, they:

- Randomly divided the university 1st year chemistry students into 2 groups: (a) treatment group (97 students) – the group that received the at-home quantum tutors, and (b) the control group (138 students) – did not receive the at-home tutor, but received the same course instruction as the treatment group.
- Gave both groups the usual lecture discussing how to assign oxidation numbers and both were given a pre test
- Gave both groups the same home work assignments
- Gave both groups a post test in the end

Results revealed:

(a) 41.2% of students in the tutor group solved 80% or more of the post test problems correctly compared to 15.9% of the students in the control group

(b) On average, there was a 45 point score increase between pre and post test results for the tutor grouping (i.e. treatment group) (info@quantumsimulations.com).

SUMMARY

Tutors are interactive computer software that may help to further enhance the chemistry, biology, mathematics, and accounting classroom teaching and learning process. The usage of the interactive software allows students to be actively engaged in their own learning process. Through students' active engagement in their own learning, meaningful learning can result from students' active thinking, problem solving, and scientific inquiry.

Moreover, there are some studies that have reported on the important gains of artificial tutors on the k-12 learning process. Some of the gains that have been reported are: increases in science achievement scores, and increases in students' attitudes toward science instruction and subject content (Kulik, 2002; Willis, 2000).

CHAPTER III – METHODOLOGY

Overview

(1) To assess the effectiveness of tutoring software on urban students' science achievement. Can tutors improve students' science achievement? What is revealed by teachers' interviews?

METHODS & DATA SOURCES

Qualitative Design

- 3 practitioners – 3 science teachers were interviewed on February 7, 2008.
- A semi-structured interview format was employed, so the interviewer was free to rephrase the interview question(s) to suit the needs of the interviewees.
- Two areas of interest investigated were: (a) benefits (or not) of software tutors on science teaching (in general); (b) software tutors affect on high stakes tests

LIMITATIONS / BIAS OF STUDY

Due to time restraints and limited resources, only a few Baltimore City (BCPSS) practitioners were selected for the interview through convenience sampling, rather than by true random sampling. Therefore, the interview of the few BCPSS practitioners can not be seen as generalizable to most teachers' views representing Maryland as a whole. Future research may address these limitations.

Qualitative Results and Findings

- About 66% of practitioners interviewed mentioned that tutoring software(s) would be beneficial to science learning in the K-12 classrooms.
- 66% of those interviewed said tutoring software(s) was good for *reinforcing* and *supporting lectures*.

Practitioner 1 (science):

"I have used tutoring software in the SAT Preparatory Program. Kaplan workbook has software as part of the package. It is used in the curriculum as a support for lecture and also as a diagnostic tool. This software grades and analyzes weaknesses and instructors can review those particular concepts."

Practitioner 2 (science):

"Interactive software that is user-friendly could be instrumental in reinforcing concepts not well understood in a regular classroom set-up. In chemistry, things such as chemical reactions, bonding, octet rule, just to name a few can be taught using various interfaces of tutoring software."

Sixty –six percent of those practitioners interviewed indicated that the tutoring software can serve as a great *motivational tool* for science students.

Practitioner 2 (science):

"Since most of the software is interactive, some that incorporate multiple intelligences could be useful in capturing the attention of even the least motivated students in the class."

Practitioner 3 (science):

"I have never used tutoring software in the school I teach at, and I have never seen any of my colleagues use it. This is primarily due to lack of resources in urban schools. However, I think if they are available, such software would raise student performance in math and science. The use of technology is in itself a motivating factor among the students."

Sixty – six percent of the practitioners interviewed talked about the effectiveness of tutoring software in possibly helping to *improve high stakes science test scores* for K-12 students.

Practitioner 2 (science):

"Yes, I believe so that they would improve scores. Since they are a sort of hands-on way of learning, the students are able to do practice over and over without the monotony of

sitting down at a desk and chair learning the concepts. The students would therefore score better on the high stakes tests since the concepts would be well understood."

Practitioner 3 (science):

"If other variables within the urban schools setting are constant, I guess student performance in high stakes test would improve. The tools can only be beneficial if used wisely by the students as well as the teacher. I think so because most of the tutoring software can differentiate variety of methods depending on the capability of the students, thus catering for individual difference among the students."

Summary of Qualitative Results and Findings

- 66% of the practitioners interviewed said that tutoring software was good for *reinforcing* and *supporting lectures.*
- 66% of the practitioners interviewed indicated that tutoring software could serve as a *motivational tool* for science students.
- 66% of the practitioners interviewed stated that tutoring software can *improve high stakes science test scores*.

CONCLUSION & RECOMMENDATIONS FOR FUTURE RESEARCH

Although the study was a qualitative study and did not focus on heavy quantitative findings like those studies conducted by Kulik (2002) and Willis (2000), still the study's qualitative findings were similar to those of these two quantitative studies:

(a) Interview data revealed that 66% of the Baltimore City teachers viewed tutoring software as a motivational tool in helping to improve students' science test scores, and this was in sync with Kulik's (2002) quantitative report in which he revealed that students' attitude

scores were raised by 1.10 standard deviations as a result of students utilizing tutors as a part of their studies.

(b) Interview data also revealed that ~60% of Baltimore City teachers felt that the use of tutoring software could help to improve high stakes test scores in science; this was in line with the actual quantitative findings of Willis (2000) whose experimental study with 51 high school students found that quantum tutors were very effective in increasing students' test scores, causing students post test grades to be on average one letter grade above that of their pre test grade.

It is recommended that more qualitative studies be conducted that will explore and seek to understand the perspectives and views of urban teachers with regards to the effects or benefits of tutoring software on their students' science achievement.

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